Radioactive Isolation Consortium, LLC

Advanced Vitrification System

Technology Need:

For permanent disposal of high level radioactive nuclear waste material (HLW) now stored at former nuclear materials production sites, such as Hanford and Savannah River, the HLW must be incorporated into a stable, environmentally safe glass that can be placed in a long-term geologic repository. The present approach for producing the HLW glass involves melting a mixture of HLW and glass-making material ("frit") in a large, electrically heated, high temperature, refractory lined container (the "melter") and pouring the resultant highly radioactive liquid glass into stainless steel canisters, which are then welded shut, externally decontaminated, and prepared for the repository.

The above approach is expensive and requires complex multiple remote handling operations. Furthermore, because of the material and operational limitations of the melter, the HLW loading in the product glass is in the range of about 25% to 50% by weight, necessitating a large number of disposal canisters, and the melter is restricted in the composition of the HLW waste it can process.

Technology Description:

The Advanced Vitrification System (AVS) is a new approach in which HLW/frit mixtures are directly melted inside modified final disposal modules, which, after cooling, are sent to the geologic repository. An AVS module consists of a conventional stainless steel canister having an internal alumina-lined graphite crucible. The crucible holds the HLW/frit mixture to be melted and is thermally insulated from the module's outer steel canister. When inductively heated by a low frequency (~30 Hertz), externally applied, AC magnetic field (~300 Gauss), the graphite/alumina crucible reaches a high temperature (i.e., ~1300° C or greater), while the insulated outer steel canister remains at lower temperature. In order to minimize radioactive contamination during module processing, the modules are connected to an off-gas handling system prior to their final sealing.

Conceptual view of AVS operating facility

The graphite and alumina crucibles, thermal insulation, and stainless canisters can be manufactured in existing commercial factories. The inductive AC heating and air cooling equipment for the module are also available commercially. The module remote handling and inspection equipment, hot cells, waste feed system, etc., all appear to be within the present state of the art.

Benefits:

- The high temperature materials in the module are exposed to molten glass only once for only a few hours, instead of the many planned operating cycles for conventional melters.

▸One-time use of the melter means that the AVS module can process a wider range of HLW compositions than a conventional melter.

▸Failure of a module will not stop system operation, which is not the case for conventional melters.

▸The area required for handling radioactive materials at AVS facilities is potentially smaller, posing less of an environmental burden from operations and decontamination and decommissioning.

▸The AVS has the potential to handle a wider range of HLW compositions.

▸The system has the potential for lower costs than conventional melter facilities.

▸The system concept allows cost-effective operation at sites with relatively small amounts of HLW.

Status and Accomplishments:

The objective of this project is to conduct bench-scale vitrification tests, using DOE provided waste simulant recipes, to demonstrate the ability of the AVS test equipment to produce simulated waste forms that meets the DOE defined technical criteria for immobilized high-level waste at the Hanford site. These technical criteria are the current revision of Waste Acceptance Product Specifications (WAPS).

The first series of 5 inch diameter AVS bench scale vitrification tests, using DOE-provided waste simulant slurry, were completed in 2001. A separately dried and pretreated waste simulant powder was batch loaded into the alumina lined graphite AVS test canister before being placed inside the AVS induction heating coils. These tests produced borosilicate glasses at waste loadings of 35% and 50%, not accounting for the reduced usable volume of the AVS canister. The AVS canister currently has an internal volume that is 76.5% of the Waste Treatment Plant reference canister. An independent evaluation sponsored by the DOE found that these test glasses were in compliance with the WAPS waste leachability and durability requirements, but they did not meet the WAPS chemical composition and phase stability requirements.

DOE determined that additional bench-scale tests are necessary to conclusively determine whether the AVS can meet the technical criteria currently required to treat high level waste at the Hanford site.

Work is currently primarily focused on preparing for a second series of 5 inch diameter AVS bench scale vitrification tests, using a different waste simulant. Developmental work is also proceeding on various waste simulant feed forms and feed equipment to replace the experimental dry powder batch loading used in the first series of AVS tests. Up to 4 AVS bench scale vitrification tests are scheduled to be completed by the end of November, 2002.

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Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 2404
http://ost.em.doe.gov/tms

The National Energy Technology Laboratory Internet address is http://www.netl.doe.gov